in air. From the modification of their appearance, and the measurements originally made from them, their identity was not quite apparent, although probable.

It thus appears that, with the spark, the cyanogen spectrum is nothing like so strongly marked, as is the case with the flame of the gas, only one group of bands being represented, and that when the spectrum is taken in air the cyanogen does not appear, because in all probability the substance is oxidised.

I have already stated that the formation of cyanogen which yields the characteristic spectrum is a synthetical operation, that compound substances, when burnt in flames, do not, as a rule, emit the spectrum of the compound, but the spectrum of one or more of the elements of which it is composed, or that of one or other of its products of combustion.

How then are we to account for the cyanogen spectrum in the flame of burning cyanogen?

The conditions under which combustion takes place are these: there is an excess of the gas, the temperature of the flame is exceedingly high, and the gas within it is not in contact with a solid substance, hence immediate decomposition does not occur, and the gaseous compound is heated to incandescence.

"Variation in *Portunus depurator*." By Ernest Warren, B.Sc., Demonstrator of Zoology at University College, London. Communicated by W. F. R. Weldon, F.R.S. Received July 1, 1896.

The following measurements were undertaken at the proposal of Professor W. F. R. Weldon, and to him I am greatly indebted for many suggestions, and for the kindly help he has always so readily given me.

The crabs were obtained from the Biological Station at Plymouth, and sent at intervals during a period of about two years, dating from the autumn of 1893. Only males were measured. Seven measurements were made on each individual, corresponding to those made by Professor Weldon on the female of *Carcinus moenas* ('Roy. Soc. Proc.,' vol. 54).

1. Carapace length, AB (fig. 1).
2. Total carapace breadth, CC′.
3. Frontal breadth, DD′.
4. Right antero-lateral, AC.
5. Left antero-lateral, AC′.
6. Right dentary margin, CD.
7. Left dentary margin, C′D′.

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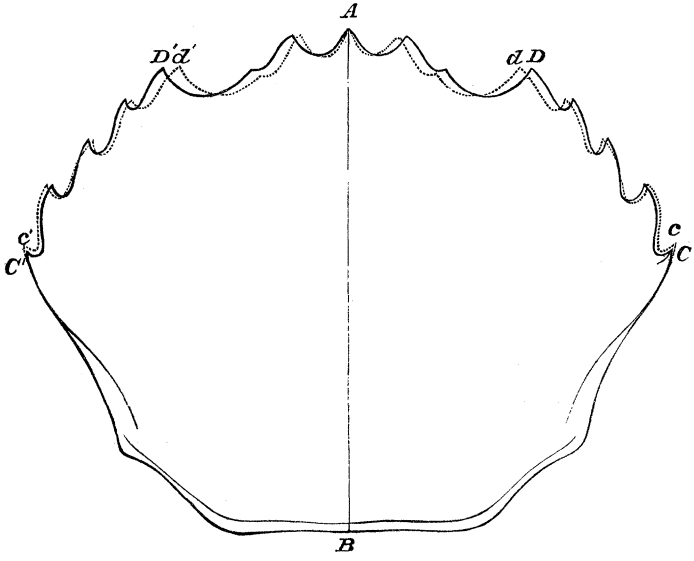
The total number of crabs measured was 2300. The determinations were made with compasses and a 3-decimetre ivory scale divided into half millimetres. The measurements were recorded to the tenth of a millimetre. As a test of accuracy, fifty crabs were indiscriminately taken out of a large number which had previously been measured; these were remeasured, and the results compared with those before obtained. It was found that the mean difference between any two measures of the same dimension was 0·107 mm.

FIG. 1.—*Portunus depurator* ♂ (Plymouth, 1893–95).



Continuous outline represents a crab with carapace length AB = 28·5 mm. Dotted outline represents a crab with carapace length AB = 46·8 mm.

Since the crabs were growing, and so varied much in size, it was necessary to reduce the measures to percentages of some standard dimension. The carapace length (AB) was selected, and all the measurements are expressed as thousandths of this dimension.

The first point to ascertain is whether the mean of the different "organs" varied as the crab increased in size. To determine this, the crabs were sorted into groups, according to the length of their standard dimension, then the arithmetic mean was found for the remaining six dimensions. In each group the change in length of carapace was comparatively small, and had to be neglected. The following table gives the results which were thus obtained:—

Grouping according to length of standard dimension.				Total breadth.		Frontal breadth.		R. antero-lateral.		L. antero-lateral.		R. dentary margin.		L. dentary margin.	
	Carapace length (AB) in millimetres.	Approximate length, corresponding to mean given.	No. of individuals in the group.	* Arithmetic mean.	† Error of mean square.	Arithmetic mean.	Error of mean square.	Arithmetic mean.	Error of mean square.	Arithmetic mean.	Error of mean square.	Arithmetic mean.	Error of mean square.	Arithmetic mean.	Error of mean square.
1	20·0—24·9	22·5	17	1291·794	—	765·029	—	784·558	—	785·265	—	463·382	—	466·029	—
2	25·0—31·9	28·5	182	1290·874	4·66	728·467	4·12	781·016	3·18	783·280	3·30	470·731	3·73	467·884	3·35
3	32·0—34·9	33·5	178	1297·421	5·15	715·163	3·58	781·387	3·08	780·781	3·22	476·264	3·98	475·736	3·41
4	35·0—35·9	35·5	164	1300·036	5·34	708·085	3·38	779·378	3·21	777·427	3·11	474·841	3·18	474·232	3·17
5	36·0—36·9	36·5	171	1299·120	5·11	704·915	3·55	779·909	3·38	779·091	3·11	479·933	3·68	476·535	3·76
6	37·0—37·9	37·5	226	1301·332	5·00	701·358	3·50	780·703	3·03	779·482	2·94	480·385	3·51	479·721	3·22
7	38·0—38·9	38·5	234	1300·927	5·06	699·996	3·19	779·055	2·93	778·081	3·04	478·406	3·24	477·850	3·28
8	39·0—39·9	39·5	256	1300·297	5·10	695·891	3·15	777·812	2·94	777·031	2·99	478·187	3·54	477·140	3·49
9	40·0—40·9	40·5	230	1301·578	4·86	694·474	3·30	778·300	2·79	777·135	2·81	478·526	3·39	477·995	3·34
10	41·0—41·9	41·5	217	1303·689	4·97	690·753	3·35	779·767	3·06	778·182	2·99	481·113	3·37	480·288	3·42
11	42·0—42·9	42·5	139	1300·011	4·91	688·291	3·45	780·953	3·20	776·694	2·99	480·205	3·63	479·651	3·61
12	43·0—43·9	43·5	130	1299·854	5·48	684·054	3·48	777·561	3·57	776·161	3·49	480·884	4·10	480·008	4·10
13	44·0—44·9	44·5	84	1301·357	5·29	681·833	3·33	779·166	3·46	777·595	3·15	482·690	4·01	481·738	3·91
14	45·0—48·6	46·8	72	1300·611	6·12	675·778	3·97	777·000	3·53	776·111	3·34	484·055	4·40	482·333	4·30

* In thousandths of carapace length. † In terms of ·004 of carapace length.

As an example we may take the total breadth. Here the observed range of variation is from 1370 to 1227 thousandths of the standard. The unit of deviation employed is 0·004 of the carapace length; thus, with this unit the range of deviation in the total breadth is expressed by the number 36. The crabs varied in absolute length of the standard from 20·0—48·6 mm., and in the fourteen groups the means are expressed in thousandths of carapace length, but the errors of mean square and all the constants that will hereafter be given are expressed in terms of the above unit of deviation.

The length of the standard is taken as a criterion of age; this may, of course, be only roughly true, and it seems quite possible that the somewhat large fluctuations which are observed in the means are due to the groups being in reality slightly heterogeneous by including crabs of somewhat different ages.

On glancing down the means of the several dimensions, it will be seen that a state of equilibrium is nowhere reached except perhaps in the case of the total breadth; thus, throughout life the crab is gradually changing its shape. This species, like the closely allied *Carcinus moenas*, is probably sexually mature when only some 20—30 mm. long;* hence, when all its organs are in a rapid state of change the crab can propagate its species. Here is an argument, so it would seem, against the transmission of acquired characters, for otherwise the earlier broods would tend to have a somewhat different shape to the later ones, and this is scarcely probable. To illustrate this change in shape fig. 1 was prepared. The continuous outline represents a crab with carapace length = 28·5 mm.; the broken outline is the *same* crab when it has grown to 46·8 mm.; the angle CAC′ opens out by about a degree. This, of course, is only true on the supposition that natural selection has not occurred with respect to these dimensions. The error of mean square of each group is given in the columns to the right of the means. This constant we take as a measure of the variability of an organ, and in no case is there a distinct tendency for it to diminish as we pass down to the groups containing the older crabs, while in the dentary margins there is an obvious increase. Hence, at the present period in the life of the species we have no evidence of selective destruction with regard to the dimensions here discussed. It is possible, however, that all the dimensions are really more variable as the crab grows older, but that this greater variability is concealed by the action of natural selection in all cases except in the dentary margins.

We will now treat each organ separately.

Total Breadth.—On referring to the table, it will be seen that groups 4—14 have means which remain fairly steady, and show

* This point is now being investigated. Female Carcinus occurs in berry when only some 20 mm. long.

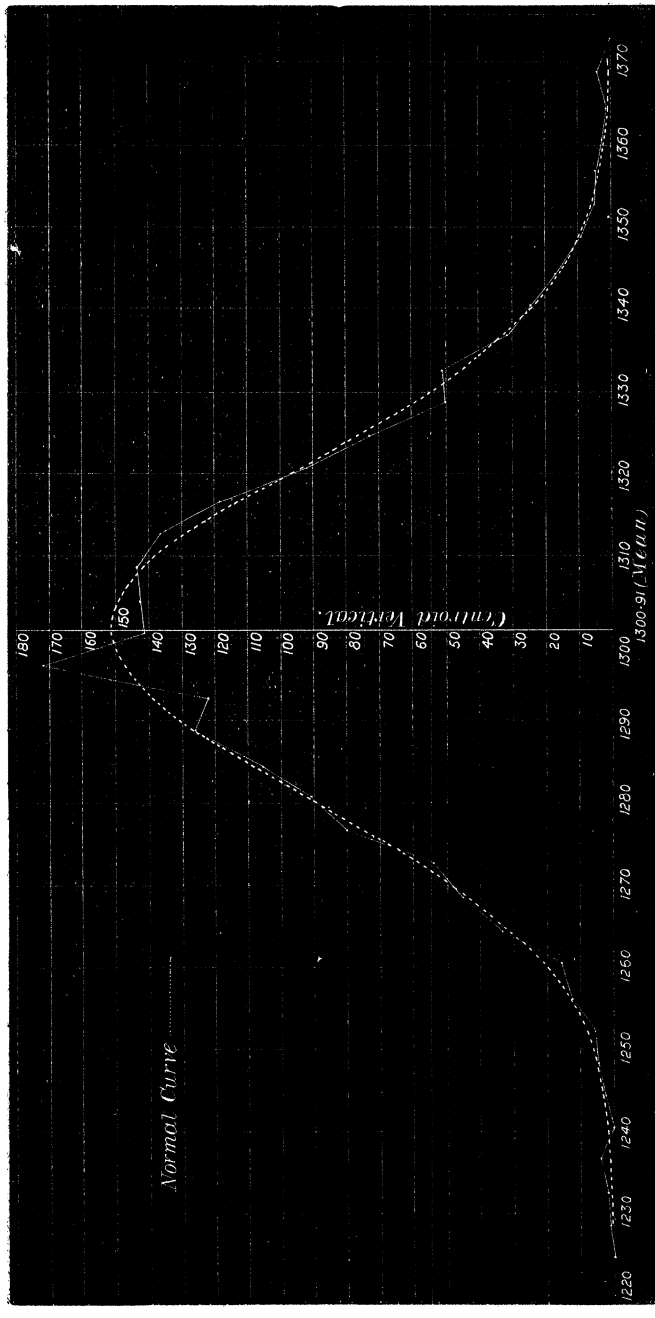


FIG. 2.—Total Breadth. 1923 Individuals.

Horizontal scale represents thousandths of carapace length. Vertical scale represents number of individuals.

no marked tendency either to rise or fall. With these 1923 individuals a curve of frequency was drawn (fig. 2). Its constants were calculated by the method employed by Professor Karl Pearson ('Phil. Trans.,' vol. 186). Range of variation = 1227—1370 thousandths of standard, unit of deviation is 0·004 of carapace length; therefore the observed range = 36 units, reckoning from 1227 upwards.

Centroid vertical (= position of arithmetic mean) = 19·102964.

The second moment about the centroid (μ_2) = 26·400476.

Standard deviation (error of mean square), $\sigma = \sqrt{\mu_2} = 5{\cdot}138139$.

Third moment (μ_3) = 0·681766.

Fourth moment (μ_4) = 2203·762099.

β_1, which is $\mu_3^2/\mu_2^3 = 0{\cdot}000025$; $\beta_2 = \mu_4/\mu_2^2 = 3{\cdot}161849$.

The critical function $2\beta_2 - 3\beta_1 - 6 = 0{\cdot}323623$ is positive, and so the theoretical curve has an unlimited range.

Professor Pearson's measure of skewness for a curve of unlimited range is given by the formula

$$\tfrac{1}{2}\sqrt{\beta_1}\,\frac{r-2}{r+2} \text{ where } r = \frac{6\,(\beta_2-\beta_1-1)}{2\beta_2-3\beta_1-6}.$$

Here $r = 40{\cdot}080414$ and skewness = 0·002262. It is clear from the values of the constants that the generalised probability curve would not differ perceptibly from the symmetrical normal curve, where $\beta_1 = 0$ and $\beta_2 = 3$.

The areal deviation of the curve of observation from the normal curve is only 5·1 per cent. of the whole area.

Frontal Breadth.—It will be seen from the table that throughout the life of the crab the mean of this dimension falls steadily; as the crab grows the forehead becomes relatively shorter. On this account it is difficult to obtain a satisfactory idea of the distribution of deviations. The means of groups 6—7 do not differ widely, and so with these the constants of variation were calculated. The observed range throughout the whole series was 640—795 thousandths of standard, and so there are 39 of our units of deviation. The range in groups 6—7 (including 460 crabs) was 648—747 thousandths, that is, 25 units.

Centroid = 13·791305. μ_2 = 11·236156.

σ = 3·352036. μ_3 = 2·800794.

μ_4 = 442·572048.

β_1 = 0·005529. β_2 = 3·505490.

r = 15·084346. Skewness = 0·02845.

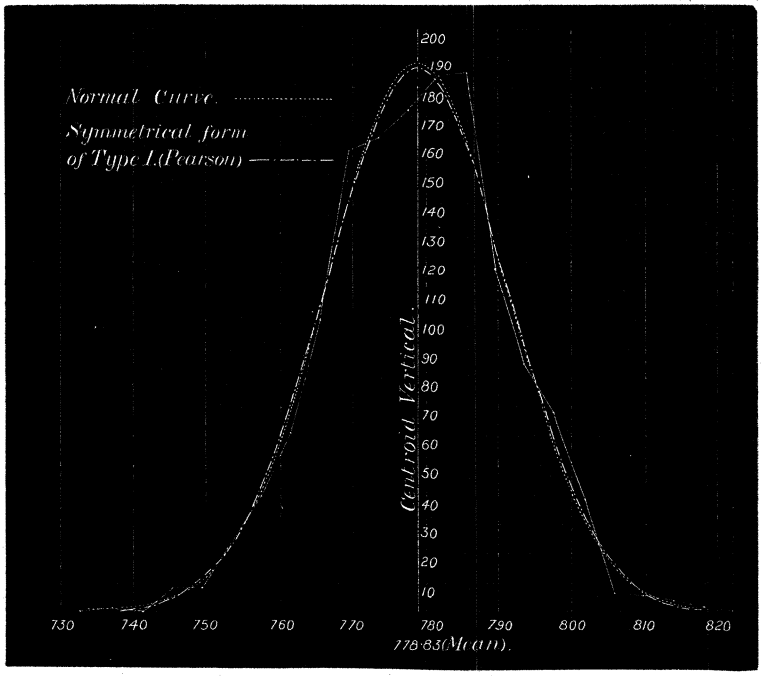
Here again the critical function $2\beta_2 - 3\beta_1 - 6 = 0{\cdot}994393$ is positive

and so the generalised probability curve would be one of unlimited range.

R. Antero-lateral.—The mean fluctuates considerably in the different groups, but there is a slight tendency to fall. Omitting the first group as being too small, it will be seen the mean falls about one unit in the whole series.

Range of deviation = 732—831 thousandths of standard, giving 25 units of variation. We select groups 6—12 (1432 individuals) for forming a frequency curve. Here the range = 736—819 thousandths, giving 21 units.

FIG. 3.—R. Antero-lateral. 1432 Individuals (see fig 2).



Centroid = 11·331704. μ_2 = 9·296165.

σ = 3·048978. μ_3 = −1·075979.

μ_4 = 255·659399.

β_1 = 0·001441. β_2 = 2·958381.

$$r = \frac{6(\beta_2-\beta_1-1)}{3\beta_1-2\beta_2+6} = 134{\cdot}096687.$$

$$\text{Skewness} = \tfrac{1}{2}\sqrt{\beta_1}\,\frac{r+2}{r-2} = 0{\cdot}01955.$$

The critical function $2\beta_2-3\beta_1-6=-0{\cdot}087561$ is negative, and so the theoretical curve has a limited range. The calculated range was 71·313123 units, and the observed range 21 units; thus they differed very widely. The range on the positive side of the origin was 31·658658, and on the negative side 39·654465. As the frequency curve is very symmetrical, Professor Pearson's generalised curve with limited range and symmetry was taken,

$$y = y_0\,(1-x^2/a^2)^m,$$

where $y_0 = 186{\cdot}357143.$ $a = 35{\cdot}656561.$

$$m = 66{\cdot}048343.$$

The distance of maximum ordinate from centroid vertical is 0·0596, and this could not be indicated on the scale of diagram. Both this and the normal curve are drawn over the curve of observation (fig. 3). The generalised curve differs exceedingly little from the normal one, the areal deviations in the two cases being 7·7 and 7·5 per cent. respectively.

The flat top to the frequency curve made it at first seem probable that the curve was really the resultant of two normal ones. It was attempted to resolve it into its constituents by means of Professor Pearson's equation of the ninth degree ('Phil. Trans.,' vol. 185). There were three real roots to the equation; two gave quite inappropriate solutions; the third gave a negative group of sixty crabs (with standard deviation = 1·450), having its maximum ordinate situated at −1·337 from the centroid, and a positive group of 1492 crabs (standard deviation = 3·012), with maximum ordinate at − 0·0540. The selection of crabs so close to the mean would scarcely seem to correspond to any natural phenomenon, and the resultant curve, which was the difference of the two normal curves, fitted the curve of observation but very little better than the normal or skew curve in fig. 3, the areal deviation being 7·0 per cent.

L. Antero-lateral.—Here the range of the mean is somewhat larger than on the right side, being about $1\frac{1}{2}$ units. The range of deviation in the whole series is 720—823 thousandths. A frequency curve was drawn (fig. 4) with groups 6—12, where the range was 724—819 thousandths, giving 24 units.

Centroid = 14·046787. $\mu_2 = 9{\cdot}127467.$

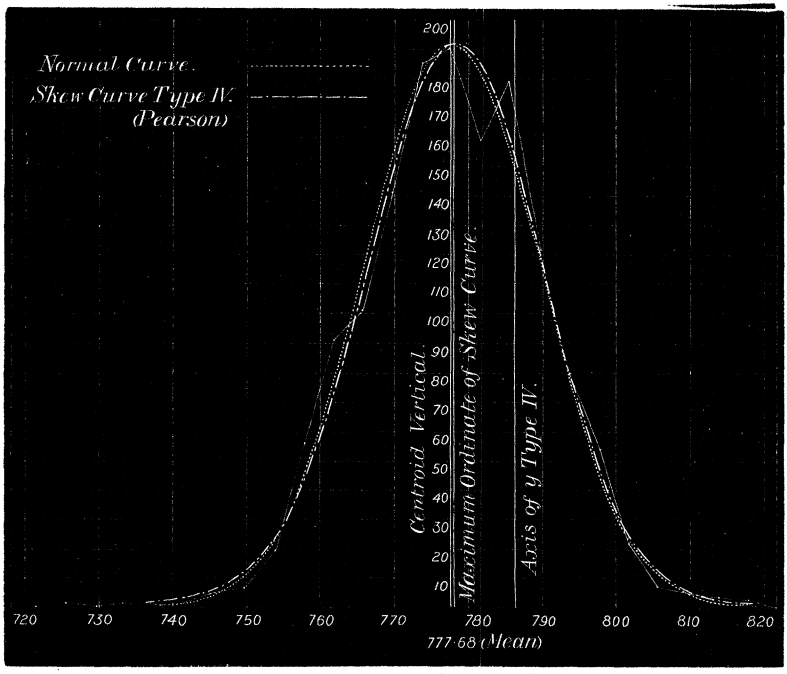
$\sigma = 3{\cdot}021170.$ $\mu_3 = -1{\cdot}885642.$

$$\mu_4 = 263{\cdot}267646.$$

$\beta_1 = 0{\cdot}004676.$ $\beta_2 = 3{\cdot}160072.$

$r = 42{\cdot}246651.$ Skewness = 0·031099.

FIG. 4.—L. Antero-lateral. 1432 Individuals (see fig. 2).



The critical function $2\beta_2 - 3\beta_1 - 6 = 0{\cdot}306116$ is positive, and so the range is unlimited, as was the case with the total and frontal breadths.

Using Professor Pearson's skew curve of unlimited range, and putting

$$x = a \tan \theta,$$

we have

$$y = y_0 \cos^{2m} \theta e^{-v\theta},$$

where $y_0 = 152{\cdot}4817.$ $v = 4{\cdot}550107.$

$m = 22{\cdot}123325.$ $a = 19{\cdot}291468.$

The distance of axis y from centroid $= 2{\cdot}077756$, and the distance of maximum ordinate from centroid $= 0{\cdot}093918$. Both this and the normal curve are drawn, and there is but very little difference between them, the areal deviations being 7·5 and 7·9 per cent. respectively.

R. Dentary Margin.—The mean has a range of about $3\frac{1}{2}$ units, and it rises as the crab grows. The total range of deviation = 436—539 thousandths. As in the other cases, groups 6—12 were selected, and a frequency curve drawn; the range is 436—531 thousandths, giving 24 units.

$$\text{Centroid} = 11{\cdot}504888. \qquad \mu_2 = 12{\cdot}483682.$$
$$\sigma = 3{\cdot}533226. \qquad \mu_3 = 1{\cdot}936527.$$
$$\mu_4 = 451{\cdot}998740.$$
$$\beta_1 = 0{\cdot}001927. \qquad \beta_2 = 2{\cdot}900359.$$
$$r = 55{\cdot}546793. \qquad \text{Skewness} = 0{\cdot}023589.$$

The critical function $2\beta_2 - 3\beta_1 - 6 = -0{\cdot}205063$ is negative, and so the theoretical curve has a limited range. This range is 53·325; in the actual statistics it is 24, and so here as in the case of the R. antero-lateral it much exceeds any conceivable limit that may exist for the crab.

L. Dentary Margin.—The trend and range of the mean resemble those of the R. dentary. The total observed range of deviation is 417—524 thousandths. In groups 6—12 the range is 425—524, giving 24 units.

$$\text{Centroid} = 14{\cdot}071229. \qquad \mu_2 = 12{\cdot}061035.$$
$$\sigma = 3{\cdot}472903. \qquad \mu_3 = -4{\cdot}649576.$$
$$\mu_4 = 438{\cdot}990665.$$
$$\beta_1 = 0{\cdot}012322. \qquad \beta_2 = 3{\cdot}017770.$$
$$r = 8438{\cdot}070126. \qquad \text{Skewness} = 0{\cdot}055527.$$

The critical function $2\beta_2 - 3\beta_1 - 6 = -0{\cdot}001426$. From this we see that the theoretical curve has a limited range; but this range would be enormous, and the curve would closely resemble a normal curve.

Correlation of the Organs.—Out of the six organs discussed, the frequency curves of three of them (total breadth, frontal breadth, and L. antero-lateral) give theoretical curves of unlimited range, while the other three (R. antero-lateral, R. and L. dentary margins) give curves of limited range. In every case the amount of skewness is small, and the diagrams show that the generalised probability curves do not give very obviously better fits than the normal curve. The fact of the R. antero-lateral giving a strictly limited range while the L. antero-lateral gives an unlimited one, demonstrates that little stress can be placed upon the type of curve which a series of observations may yield.

In the present case the curves would appear to be sufficiently normal to allow us to find Galton's function (known as r) for pairs of organs. For this purpose we shall employ the modified formula

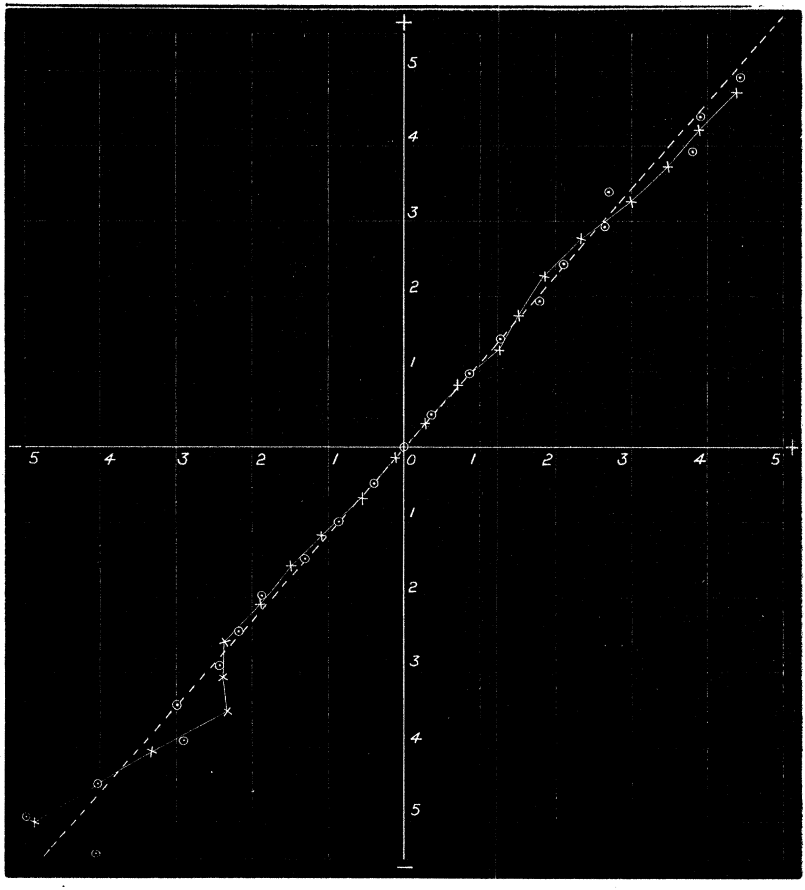
$$r = \frac{\Sigma \text{ Deviation A} \times \text{Deviation B}}{n\sigma_A\sigma_B},$$

where n = number of individuals, and σ_A and σ_B are the standard deviations of organs A and B respectively. This formula has recently been shown by Professor Pearson to be superior to the one formerly used ('Phil. Trans.,' vol. 187).

The correlation surfaces are published as being of permanent value, and it is believed that such material as this will be of use in the future in elaborating or modifying the current theory of correlation.

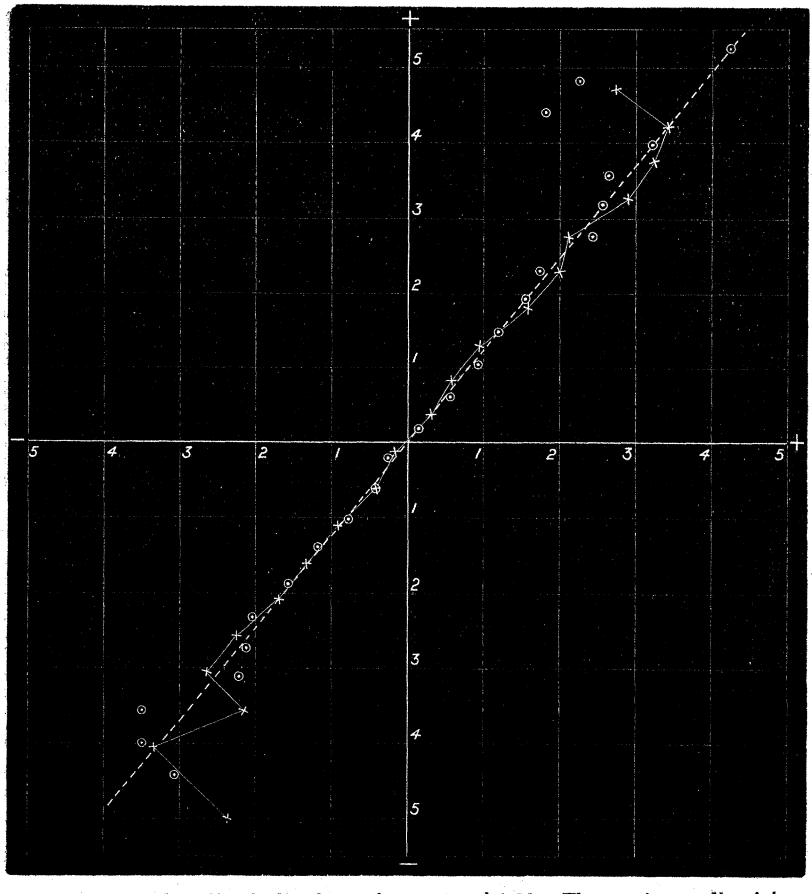
Figs. 5 and 6 represent two r lines. The crosses were obtained by

FIG. 5.—R. and L. Antero-lateral. r = 0·86.



Dotted line = the r line inclined to axis x at $\tan^{-1}$ 0·86. The continuous line joining the crosses is the line found on taking R. antero-lat. as subject. The circles indicate the points obtained when the L. antero-lat. is the subject. The probable errors of the dimensions are represented by the intervals 1, 2, 3, &c., on both horizontal and vertical scales.

FIG. 6.—R. Antero-lateral and R. Dentary. $r = 0{\cdot}80$.



Dotted line is the r line inclined to axis x at $\tan^{-1} 0{\cdot}80$. The continuous line joining the crosses is the line found on taking the R. antero-lat. as subject. The circles indicate the points obtained when the R. dentary is the subject. The probable errors of the dimensions are represented by intervals, 1, 2, 3, &c., on both horizontal and vertical scales.

taking one dimension as the subject and the other as the relative, then for every unit of deviation of the subject the mean of the associated values of the relative was found. The values of the subject and the associated mean values of the relative are expressed in terms of their probable errors, and plotted along the axes of y and x respectively. The points indicated by circles were obtained by reversing the positions of subject and relative.

It is clear that the crosses and circles do tend to lie along a line

inclined at $\tan^{-1} r$ to the axis of x. The ends of the lines are irregular on account of the impossibility of obtaining a satisfactory mean to the relative at these points because of the paucity of individuals near the limits of the range of deviation. One sees that, in these two cases at least, the correlation surfaces must closely approximate to the symmetrical normal surface.

Organs.	*Carcinus moenas.* Naples race.		*Carcinus moenas.* Plymouth race.		*Portunus depurator.* Plymouth.	
	r.	Probable error of r.	r.	Probable error of r.	r.	Probable error of r.
Total breadth and frontal breadth	0·08	0·0211	0·10	0·0210	0·14	0·0305
Total breadth and R. antero-lat.	0·66	0·0100	0·65	0·0103	0·67	0·0082
Total breadth and R. dentary	0·50	0·0143	0·55	0·0130	0·56	0·0107
Frontal breadth and R. antero-lat.	0·29	0·0187	0·24	0·0195	0·30	0·0270
Frontal breadth and R. dentary	−0·23	0·0197	−0·18	0·0203	−0·03	0·0314
Frontal breadth and L. dentary	−0·26	0·0193	−0·20	0·0201	−0·01	0·0314
R. antero-lat. and L. antero-lat.	0·76	0·0072	0·78	0·0066	0·86	0·0035
R. antero-lat. and R. dentary	0·71	0·0086	0·78	0·0066	0·80	0·0050
R. antero-lat. and L. dentary	0·60	0·0117	0·70	0·0089	0·74	0·0065

In the above table the 2nd and 4th columns give the values of Galton's functions which Professor Weldon found for two races of female *Carcinus moenas* ('Roy. Soc. Proc.,' vol. 54). The sixth column gives the values of r obtained for Portunus.

It is quite obvious that there is a marked similarity between the three columns of figures. The probable errors of r were found by the formula $0{\cdot}6745 \frac{1-r^2}{\sqrt{n(1+r^2)}}$, which Professor Pearson shows will give a close approximation ('Phil. Trans.,' vol. 187). These probable errors were added to indicate how far the differences in the values of r are to be regarded as meaning actual deviations in the constants. The values obtained for the two races of Carcinus differ from one another nearly as much as they do from the constants of Portunus.

We have thus proved that the mutual relationships of the organs measured are almost as closely similar between the two genera Portu-

nus and Carcinus as between two not very sharply marked off races of a single species.

Of course a considerable number of such comparisons would be necessary before any safe conclusions could be drawn, and the meaning of the differences observed could only be discovered by such a comparative treatment of a large series of genera. It is probable that the larger deviations do indicate real differences in the correlation constant, possibly such are associated with changes in habit or environment. For example, it is conceivable that a crab which swims might require to be more symmetrical than one that only crawls between the tide-marks. Portunus does swim to a certain extent, and one can see from the table that the correlation of the two sides of the body is greater in this genus than in the essentially shore-living *Carcinus moenas*.

I. Correlation Surface of Total Breadth and R. antero-lateral.

1432 Individuals.

Measurements in thousandths of carapace length. / Total breadth.	R. antero-lat.	736—739	740—743	744—747	748—751	752—755	756—759	760—763	764—767	768—771	772—775	776—779	780—783	784—787	788—791	792—795	796—799	800—803	804—807	808—811	812—815	816—819	
		10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	
1370—1367	17																1		2				17
1366—1363	16																						16
1362—1359	15													1					1				15
1358—1355	14																2	1					14
1354—1351	13																1	1	1				13
1350—1347	12												1		2	1	1	2		1			12
1346—1343	11												1	1		1	2	4		1		1	11
1342—1339	10											1	3	2	2	5	1	2		1			10
1338—1335	9											1	1	4	3	5	8	4	1				9
1334—1331	8									1		3		4	5	8	5	5		1	2	1	8
1330—1327	7									2		1	2	6	3	7	12	4		1			7
1326—1323	6										1	2	6	11	15	10	4	6	2				6
1322—1319	5							1		3	4	5	10	10	15	7	7	2			1		5
1318—1315	4									5	15	11	12	17	14	7	5	1					4
1314—1311	3								1	6	14	11	17	29	10	8	4	2			1		3
1310—1307	2					1	1	2	3	8	11	14	22	21	9	10	6	2					2
1306—1303	1					1	2	3	6	15	8	13	14	14	12	8	5	3		1			1
1302—1299	0							3	2	8	16	26	18	21	7	4	3						0
1298—1295	1				1	2	1	7	7	19	16	23	22	20	10	3							1
1294—1291	2					1	3	4	11	9	22	18	16	5	1								2
1290—1287	3			1	2	3	3	7	13	15	16	13	15	6	5		1						3
1286—1283	4						4	5	15	12	12	9	13	4	2								4
1282—1279	5			1	1	4	4	6	8	17	11	7	2	5	2	1							5
1278—1275	6					3	3	7	9	14	6	7	5	2									6
1274—1271	7					4	4	6	9	9	4	2	1	1									7
1270—1267	8			1	2	3	5	1	7	5	2	2	1	1									8
1266—1263	9			2	1		4	2	4	5		2	2										9
1262—1259	10					2	2	1	2	1	4	1											10
1858—1255	11			3	1		1	1	2	3													11
1254—1251	12	1					1	1	1		1												12
1250—1247	13							2		1													13
1246—1243	14						1																14
1242—1239	15																						15
1238—1235	16						1	1															16
1234—1231	17																						17
1230—1227	18							1															18
		10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	

II. Correlation Surface of Total Breadth and R. Dentary.

1432 Individuals.

Measurements in thousandths of carapace length. / Total breadth.	R. dentary.	436—439	440—443	444—447	448—451	452—455	456—459	460—463	464—467	468—471	472—475	476—479	480—483	484—487	488—491	492—495	496—499	500—503	504—507	508—511	512—515	516—519	520—523	524—527	528—531	
		10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	
1370—1367	17																1			2						17
1366—1363	16																									16
1362—1359	15										1								1							15
1358—1355	14																2	1								14
1354—1351	13														1	1					1					13
1350—1347	12												1	1		3			1	2						12
1346—1343	11													1	2	3	1	1	2			1				11
1342—1339	10										2		3	1	1	3	3	2	2							10
1338—1335	9										1		3	3	3	5	1	5	3	1	2					9
1334—1331	8										1	3	2	6	3	3	2	4	8	3						8
1330—1327	7							1				3	4	4	2	8	6	4	2	3	1					7
1326—1323	6								1	1	3	2	7	10	10	5	6	5	5	1	1					6
1322—1319	5				2			1	1	4	2	4	10	12	9	7	3	5	1	3					1	5
1318—1315	4						1		5	8	7	12	13	12	12	9	2	2	2	1				1		4
1314—1311	3							1	3	5	10	8	26	13	14	9	8	2	1	1	1		1			3
1310—1307	2				1		2	1	4	6	18	13	17	13	10	12	8	4		1						2
1306—1303	1				1	1	5	5	7	7	16	6	15	11	8	7	5	3	4		2	2				1
1302—1299	0							7	6	7	21	7	17	14	7	11	6	4	1							0
1298—1295	1				1	4	4	9	7	10	17	22	17	17	8	5	5	4	1							1
1294—1291	2					3	3	6	10	12	12	14	17	5	5	2	1									2
1290—1287	3	1		1	1	5	5	12	10	8	18	11	10	5	5	5	1	2								3
1286—1283	4				1	2	6	3	11	12	7	7	9	8	4	2	2	2								4
1282—1279	5		1	1	3		6	7	12	9	6	9	4	3	2	2	3	1								5
1278—1275	6				3	4	4	3	7	11	8	7	5	3	1											6
1274—1271	7				1	4	9	5	4	5	5	4	1	1	1											7
1270—1267	8		1	1	2	2	5	5	2	1	2	4	2	2	1											8
1266—1263	9		1	1		1	2	4	3	4	1	1		1	1	1	1									9
1262—1259	10					1	3	2	3	1	1		1	1												10
1258—1255	11	1	1				2	1		3		2	1													11
1254—1251	12						1	1	1			1	1													12
1250—1247	13						1	1				1														13
1246—1243	14	1																								14
1242—1239	15																									15
1238—1235	16					1			1																	16
1234—1231	17																									17
1230—1227	18					1																				18
		10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

III. Correlation Surface of Frontal Breadth and Total Breadth. 460 Individuals.

Measurements in thousandths of carapace length. / Frontal breadth.	Total breadth.	1227—1230	1231—1234	1235—1238	1239—1242	1243—1246	1247—1250	1251—1254	1255—1258	1259—1262	1263—1266	1267—1270	1271—1274	1275—1278	1279—1282	1283—1286	1287—1290	1291—1294	1295—1298	1299—1302	1303—1306	1307—1310	1311—1314	1315—1318	1319—1322	1323—1326	1327—1330	1331—1334	1335—1338	1339—1342	1343—1346	1347—1350	1351—1354	1355—1358	1359—1362	1363—1366	1367—1370	
		18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
747—744	12																											1										12
743—740	11																						1															11
739—736	10																																					10
735—732	9											1						1	1			1																9
731—728	8																2			1	1	1	1				1											8
727—724	7															1		1	1	2		3	1			1			1		1							7
723—720	6											1		1	2			1	3		1	1		2	1			1		1	1							6
719—716	5														1		2	1	2	1		1	1	1	2	2	2	1			1							5
715—712	4											1		1			2	1	2	2	2	1	3	2		2	1	1		1								4
711—708	3							1			1		1	2	1	5		4	6	2	3	4	2	2	3	2			1	4								3
707—704	2						1	1				2	1	2	3	3	6	4	8	2	4	3	4	4	1	1	1	2	1	1		1	1					2
703—700	1						1			1		1	5	3	3	4	2	3	3	5	2	7	5	5	4	4	2					1	1					1
699—696	0	1								1	3	1	2		3	1	5	2	7	11	2	2	7	4	1	2	3	1										0
695—692	1							1			2	2	3	2	2	4	1	3	6	9	2	3	1	4	2			2	2			1						1
691—688	2										1				2	3	2	2	2	3	4	3	5	3	2	2			1		1							2
687—684	3									1		1	2	2	3	1	3	1	2	1	2	3	3	1						1								3
683—680	4											1				3		2			2	2	1	1	1				1		1							4
679—676	5											1		1	1	2	2	1	1	1	1	1																5
675—672	6													1		3	2	1		1					1													6
671—668	7																			1		1						1										7
667—664	8																																					8
663—660	9																								1													9
659—656	10																																					10
655—652	11																																					11
651—648	12																					1																12
		18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	

IV. Correlation Surface of Frontal Breadth and R. Antero-lateral.

460 Individuals.

Measurements in thousandths of carapace length. / Frontal breadth.	R. antero-lateral.	748—751	752—755	756—759	760—763	764—767	768—771	772—775	776—779	780—783	784—787	788—791	792—795	796—799	800—803	804—807	808—811	812—815	816—819	
		8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	
747—744	12										1									12
743—740	11												1							11
739—736	10																			10
735—732	9					1				1		1			1					9
731—728	8							1	1	1		2	1	1						8
727—724	7					1			2	1	4	1	1		2					7
723—720	6					1		3	3		4		3	1					1	6
719—716	5							1	1	2	4	3		4	3					5
715—712	4					1	1	1	3	4	5	5			1	1			1	4
711—708	3				2	3	4	3	2	5	10	5	5	2	1	1	1			3
707—704	2	1		1	3	4	5	10	6	5	9	3	3	5	2					2
703—700	1			3		3	8	4	12	7	8	5	7	3		2				1
699—696	0			2	4	5	7	5	13	3	8	5	2	4	1					0
695—692	1		3	2	1	1	8	6	8	7	2	8	4	2						1
691—688	2			2	3	1	5	1	3	7	8	2	2	2						2
687—684	3		4	1	5	1	2	4	2	3	3		2							3
683—680	4	1	1		2		1	2	2		3	1	1	1						4
679—676	5					5	3	1	1	1	1									5
675—672	6					2		3	3			1								6
671—668	7						1			1	1									7
667—664	8																			8
663—660	9											1								9
659—656	10																			10
655—652	11																			11
651—648	12					1														12
		8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	

V. Correlation Surface of Frontal Breadth and R. Dentary.

460 Individuals.

Measurements in thousandths of carapace length. / Frontal breadth.	R. dentary.	448—451	452—455	456—459	460—463	464—467	468—471	472—475	476—479	480—483	484—487	488—491	492—495	496—499	500—503	504—507	508—511	512—515	
		7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	
747—744	12										1								12
743—740	11												1						11
739—736	10																		10
735—732	9		1					1	1					1					9
731—728	8					3				2	1			1					8
727—724	7				2	1	1	2	1		3	1			1				7
723—720	6			1		1	2	4	1	2	2		1	1		1			6
719—716	5						1	5	4	1	1	2		2	2				5
715—712	4			1		1	3	4	1	5	4	2		1		1			4
711—708	3	1	1	1	4	3	4	6	2	5	5	3	6	1		2			3
707—704	2	2		4	4	3	4	6	9	6	4	4	6	2	2	1			2
703—700	1	1	1	6	2	1	6	7	7	3	7	6	7	2	2	1	2	1	1
699—696	0		3	3	3	6	3	6	8	5	8	4	3	4	3				0
695—692	1		1	3	3	4	4	2	5	8	4	7	3	4	1	2	1		1
691—688	2	1	1	1	3	1	2	4	2	4	5	3	4	3	1	1			2
687—684	3	1	1	3	1	1	2	3	4	4		2	2	1	1			1	3
683—680	4		1	1	1	2			1	1	2	3		2		1			4
679—676	5					1	3	2	4	2									5
675—672	6						2	1		1		2	2		1				6
671—668	7										1		1		1				7
667—664	8																		8
663—660	9														1				9
659—656	10																		10
655—652	11																		11
651—648	12										1								12
		7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	

VI. Correlation Surface of Frontal Breadth and L. Dentary.

460 Individuals.

Measurements in thousandths of carapace length. / Frontal breadth.	L. dentary.	441—444	445—448	449—452	453—456	457—460	461—464	465—468	469—472	473—476	477—480	481—484	485—488	489—492	493—496	497—500	501—504	505—508	
		9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
747—744	12												1						12
743—740	11														1				11
739—736	10																		10
735—732	9					1			1		1					1			9
731—728	8					1	1		1				2	1	1				8
727—724	7					1		2	2		2	3	1	1					7
723—720	6						2	1		5	2		2	1	1	1	1		6
719—716	5								2	4		4	2	2	1	3			5
715—712	4			1				3	3	2	3	6	2	1				2	4
711—708	3			1		2	4	7	2	3	4	8	5	4	1	2	1		3
707—704	2			3		3	4	5	4	5	10	7	5	6	1	2		2	2
703—700	1				5	5		1	8	6	4	5	8	5	10	3		2	1
699—696	0	1		1	2	3	5	3	4	6	9	8	6	3	6	1	1		0
695—692	1	1	1			1	2	5	6	3	9	5	3	8	4	3	1		1
691—688	2					4	4	2	3	2	3	5	2	4		4	3		2
687—684	3				2	3	1	3	1	3	2	5	1	1	1	4			3
683—680	4					1	1		2	1	2		1	4	2		1		4
679—676	5				1	1		2	2	5		1							5
675—672	6						1	2			1		1	2	1	1			6
671—668	7												1	1			1		7
667—664	8																		8
663—660	9														1				9
659—656	10																		10
655—652	11																		11
651—648	12													1					12
		9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	

VII. Correlation Surface of R. Antero-lateral and L. Antero-lateral.

1432 Individuals.

Measurements in thousandths of carapace length. / R. antero-lateral.	L. antero-lateral.	724—727	728—731	732—735	736—739	740—743	744—747	748—751	752—755	756—759	760—763	764—767	768—771	772—775	776—779	780—783	784—787	788—791	792—795	796—799	800—803	804—807	808—811	812—815	816—819	
		13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	
819—816	10																						1		1	10
815—812	9																		1					2	1	9
811—808	8																				2	1	3			8
807—804	7																	1	1	1		2	1	1		7
803—800	6												1			1	3	3	5	7	16	3				6
799—796	5														2	1	13	7	15	29	1					5
795—792	4														2	10	14	19	29	9	2					4
791—788	3												1	1	6	12	21	54	17	5						3
787—784	2												5	12	29	27	82	19	8	2	1					2
783—780	1									1	2	2	9	24	40	62	25	15	3			1				1
779—776	0										1	7	16	37	70	21	16	3	1							0
775—772	1								2		6	13	20	76	26	17	3									1
771—768	2						1			6	16	27	64	25	10	7	2									2
767—764	3								2	10	19	40	19	6	4											3
763—760	4						1	2	3	10	27	8	5	2	2	1										4
759—756	5	1						1	6	21	9	2														5
755—752	6						1	1	6	7	6	1	1	1												6
751—748	7							2	1	1	3			1												7
747—744	8			1		1	2	1			2	1														8
743—740	9																									9
739—736	10				1																					10
		13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	

VIII. Correlation Surface of R. Antero-lateral and R. Dentary

1432 Individuals.

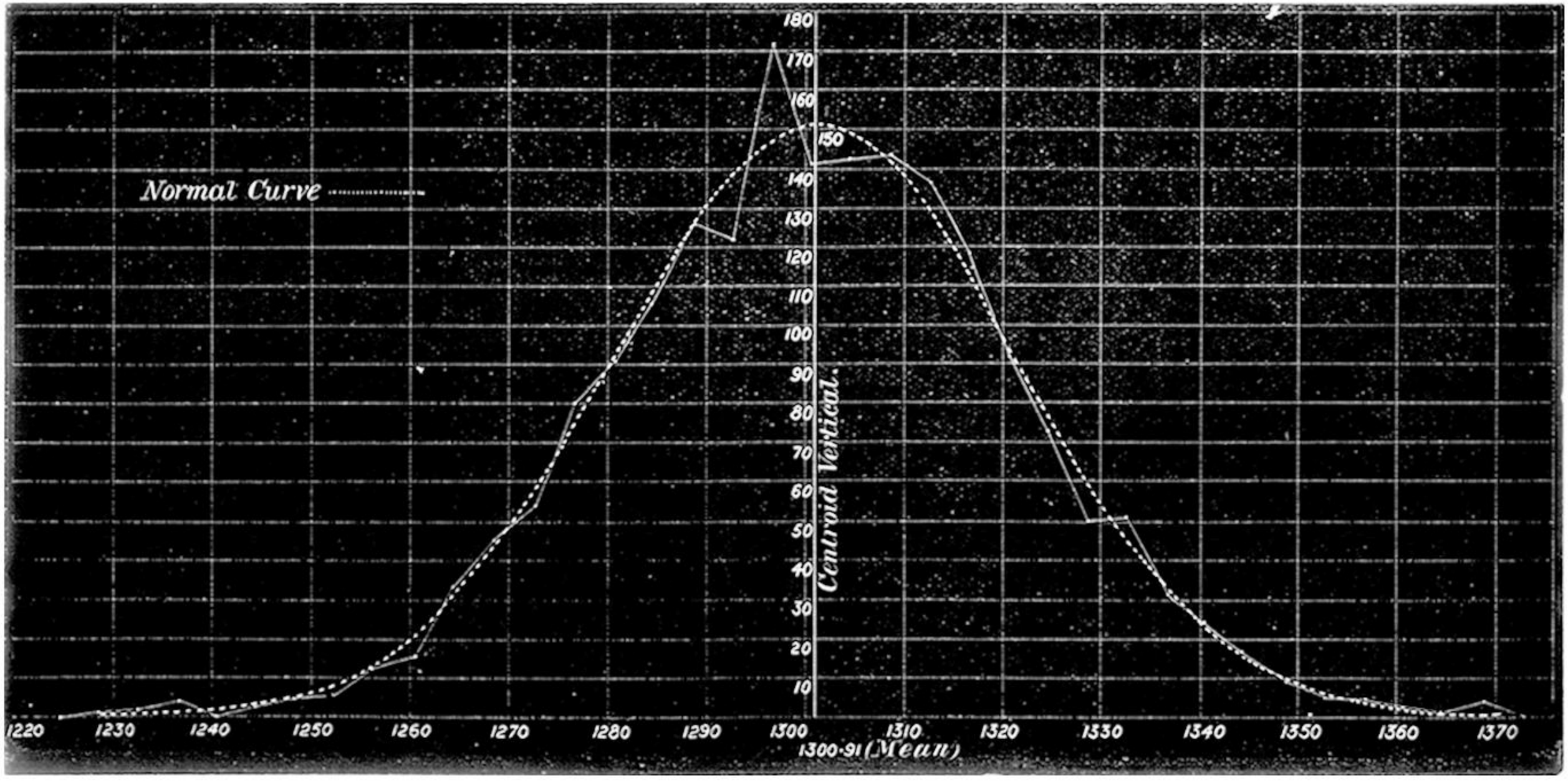
Measurements in thousandths of carapace length. R. Antero-lateral.	R. dentary.	436—439	440—443	444—447	448—451	452—455	456—459	460—463	464—467	468—471	472—475	476—479	480—483	484—487	488—491	492—495	496—499	500—503	504—507	508—511	512—515	516—519	520—523	524—527	528—531	
		11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	
819—816	10																		2							10
815—812	9																	1	1		1				1	9
811—808	8																		2	2		2				8
807—804	7																1		3	1	2					7
803—800	6													1	3	5	11	7	6	4	2					6
799—796	5						1						2	3	8	11	8	13	10	10		1		1		5
795—792	4												6	11	11	20	16	12	5		3		1			4
791—788	3									3	5	5	16	22	23	21	10	8	3	1						3
787—784	2							1	1	4	16	18	33	41	32	25	10	4								2
783—780	1					1		1	5	12	21	24	42	32	17	13	9	5	2							1
779—776	0					1		5	10	17	32	36	36	16	11	6	1	1								0
775—772	1				1	1	3	6	16	22	36	27	32	13	3	2	1									1
771—768	2				3		8	22	24	30	30	20	13	6	2											2
767—764	3					6	17	13	19	16	14	8	5	2												3
763—760	4				5	6	5	14	17	6	5	2	1													4
759—756	5	2			3	9	11	6	5	3		1														5
755—752	6		2	2	2	4	9	5																		6
751—748	7				1	1	3	1	1	1																7
747—744	8		2	2	1		1	1																		8
743—740	9																									9
739—736	10						1																			10
		11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	

IX. Correlation Surface of R. Antero-lateral and L. Dentary.

1432 Individuals.

Measurements in thousandths of carapace length. / R. antero-lateral.	L. dentary.	425—428	429—432	433—436	437—440	441—444	445—448	449—452	453—456	457—460	461—464	465—468	469—472	473—476	477—480	481—484	485—488	489—492	493—496	497—500	501—504	505—508	509—512	513—516	517—520	521—524	
		13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	
819—816	10																				1	1					10
815—812	9																			2		1				1	9
811—808	8																			3		1	1		1		8
807—804	7																		1	1	1	3	1				7
803—800	6															1	2	6	8	11	3	6	2				6
799—796	5												2		1	4	11	12	7	10	5	12	2		1	1	5
795—792	4												1		4	12	11	12	20	16	4	3	2				4
791—788	3									1	1		2	5	10	12	24	24	23	8	5	1	1				3
787—784	2									1	2	8	9	14	25	35	35	19	27	8	2						2
783—780	1			1			1			3	4	8	18	19	40	28	22	15	14	7	2		1	1			1
779—776	0								2	3	4	17	21	32	32	23	20	12	4	2							0
775—772	1							1	1	8	9	13	20	36	28	25	12	8	2								1
771—768	2							4	6	9	23	30	31	21	12	9	10	2				1					2
767—764	3					1	1	3	6	15	16	19	15	13	4	4	2	1									3
763—760	4					1	2	5	3	6	11	11	14	5		3											4
759—756	5	1	1			1	2	2	10	11	4	5	1		1	1											5
755—752	6		1			1	1	2	3	9	3	3					1										6
751—748	7									2	2		3			1											7
747—744	8				3		1		1	1	2																8
743—740	9																										9
739—736	10								1																		10
		13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	

Fig. 2.—Total Breadth. 1923 Individuals.



Horizontal scale represents thousandths of carapace length. Vertical scale represents number of individuals.

FIG. 3.—R. Antero-lateral. 1432 Individuals (see fig 2).

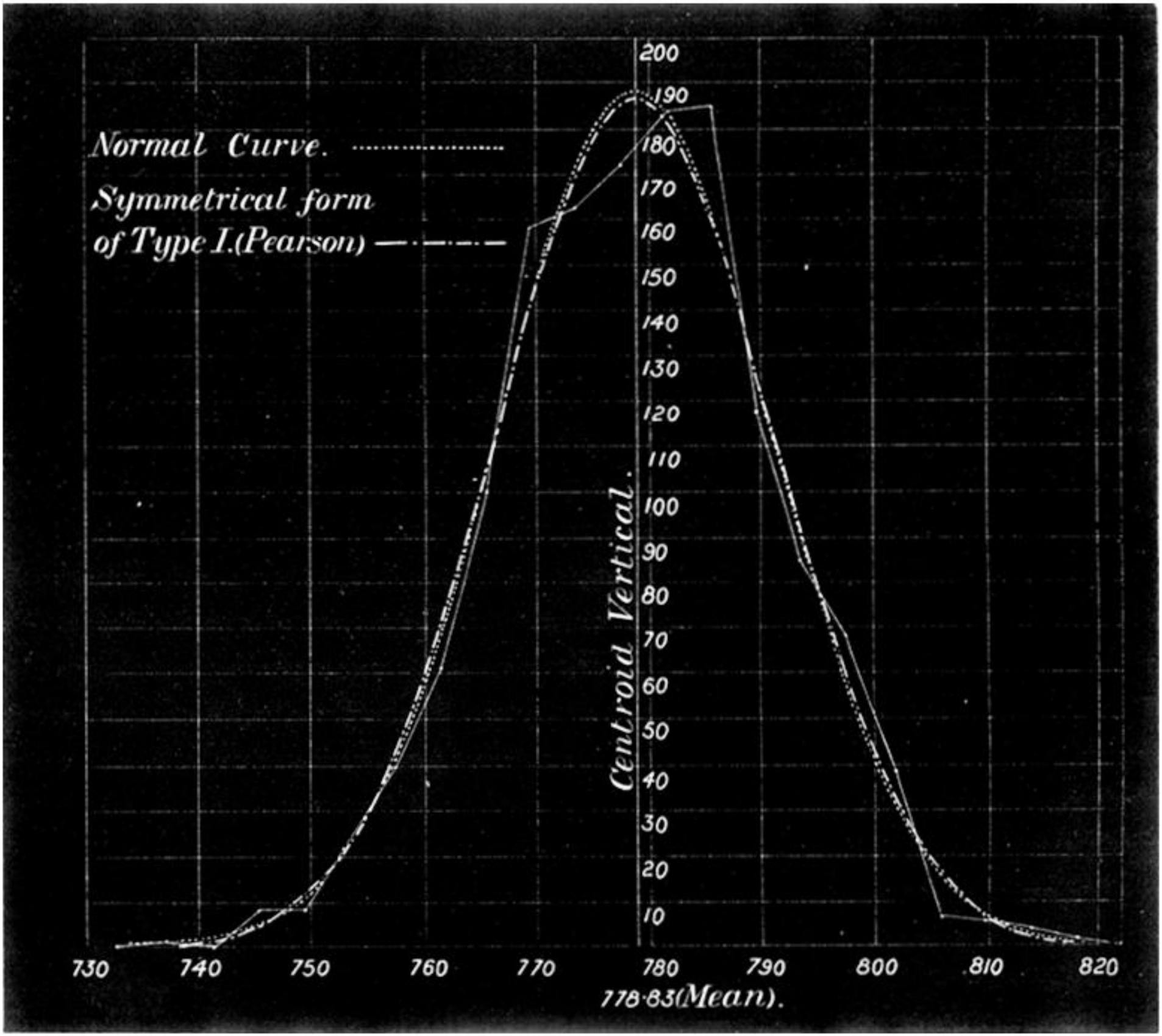


FIG. 4.—L. Antero-lateral. 1432 Individuals (see fig. 2).

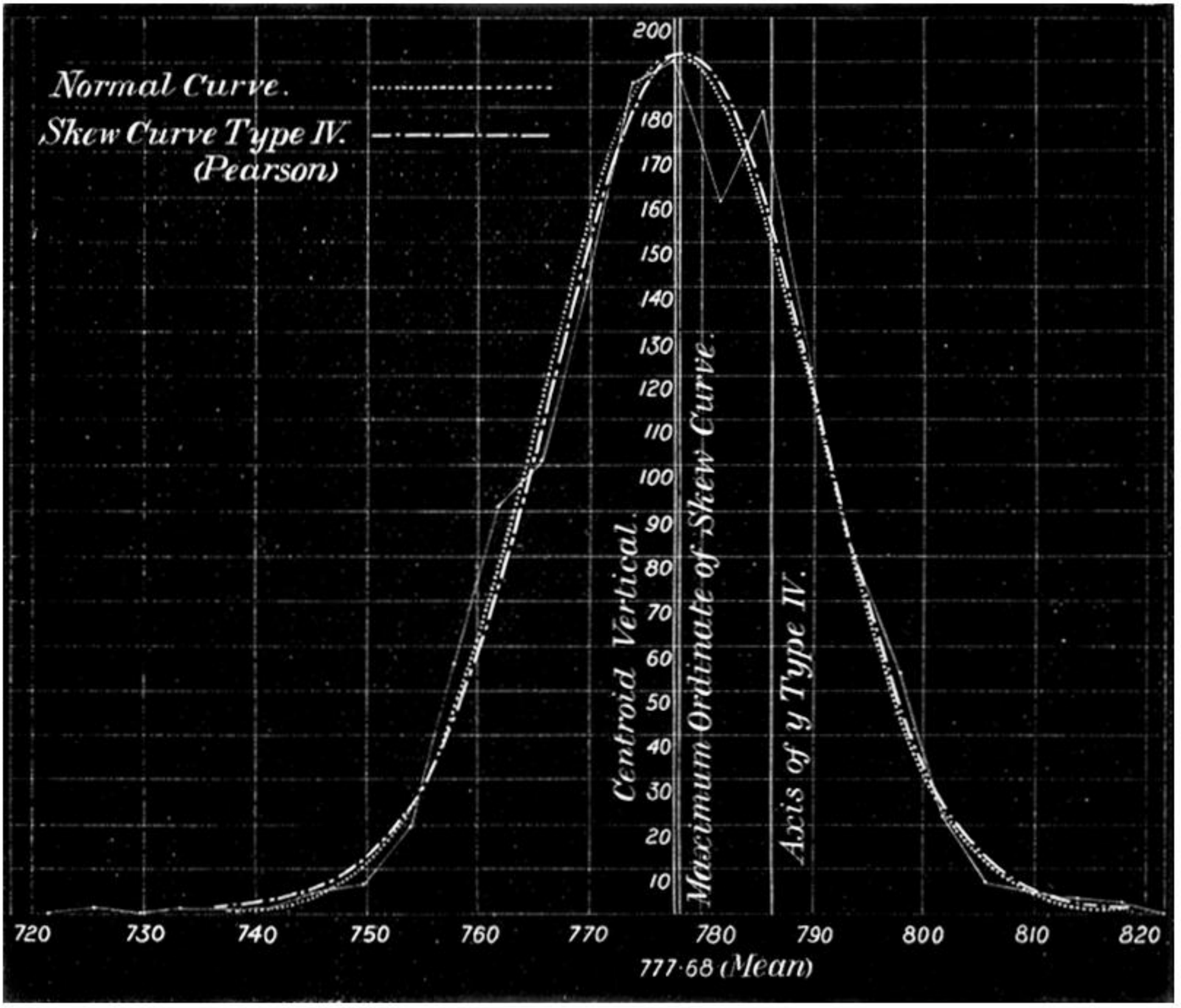
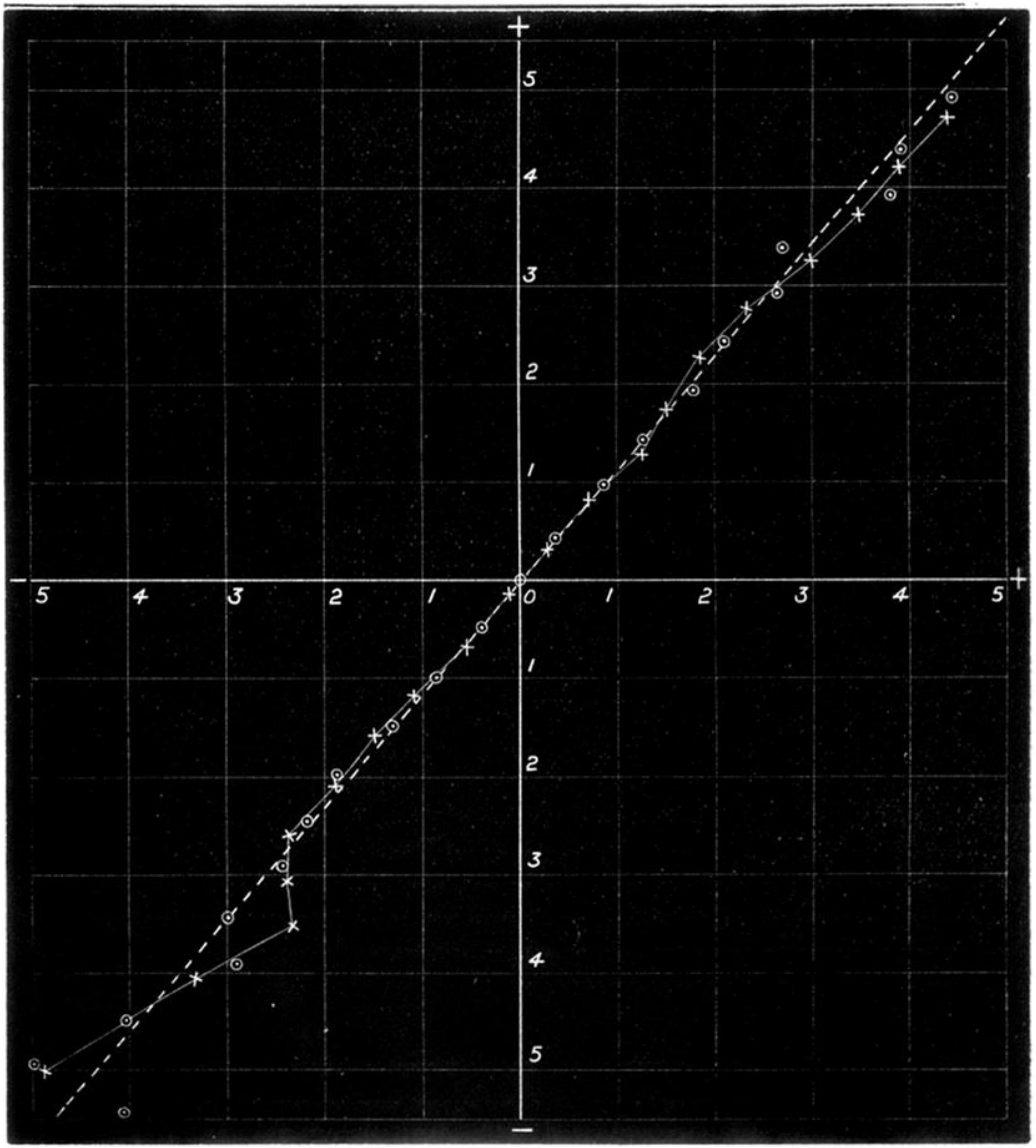
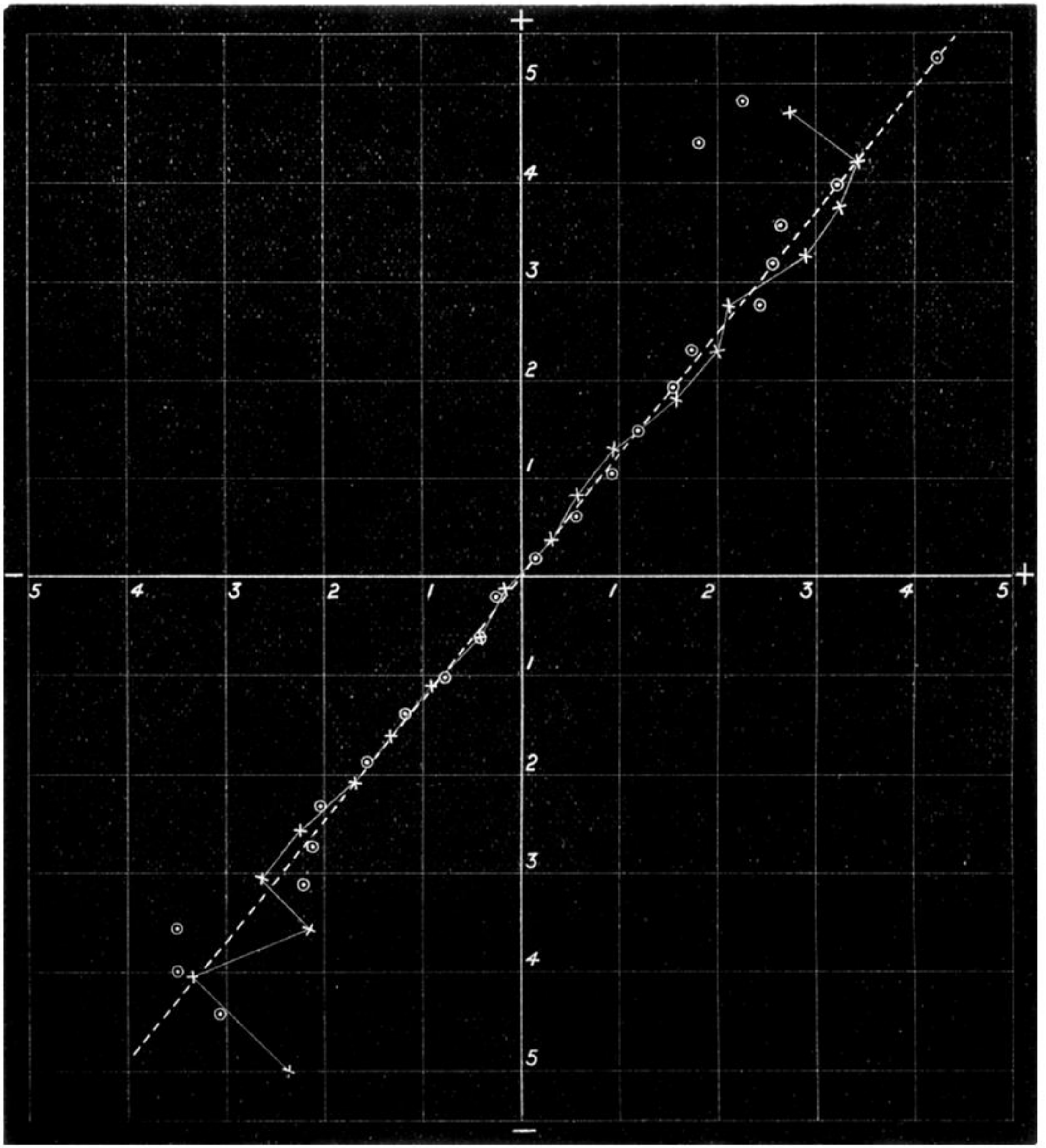


FIG. 5.—R. and L. Antero-lateral. $r = 0{\cdot}86$.



Dotted line = the r line inclined to axis x at $\tan^{-1} 0{\cdot}86$. The continuous line joining the crosses is the line found on taking R. antero-lat. as subject. The circles indicate the points obtained when the L. antero-lat. is the subject. The probable errors of the dimensions are represented by the intervals 1, 2, 3, &c., on both horizontal and vertical scales.

FIG. 6.—R. Antero-lateral and R. Dentary. $r = 0{\cdot}80$.



Dotted line = the r line inclined to axis x at $\tan^{-1} 0{\cdot}86$. The continuous line joining the crosses is the line found on taking R. antero-lat. as subject. The circles indicate the points obtained when the L. antero-lat. is the subject. The probable errors of the dimensions are represented by the intervals 1, 2, 3, &c., on both horizontal and vertical scales.